Better Buildings
U.S. DEPARTMENT OF ENERGY

Results from a Field Demonstration of Ultra-Low-Temperature Laboratory Freezers

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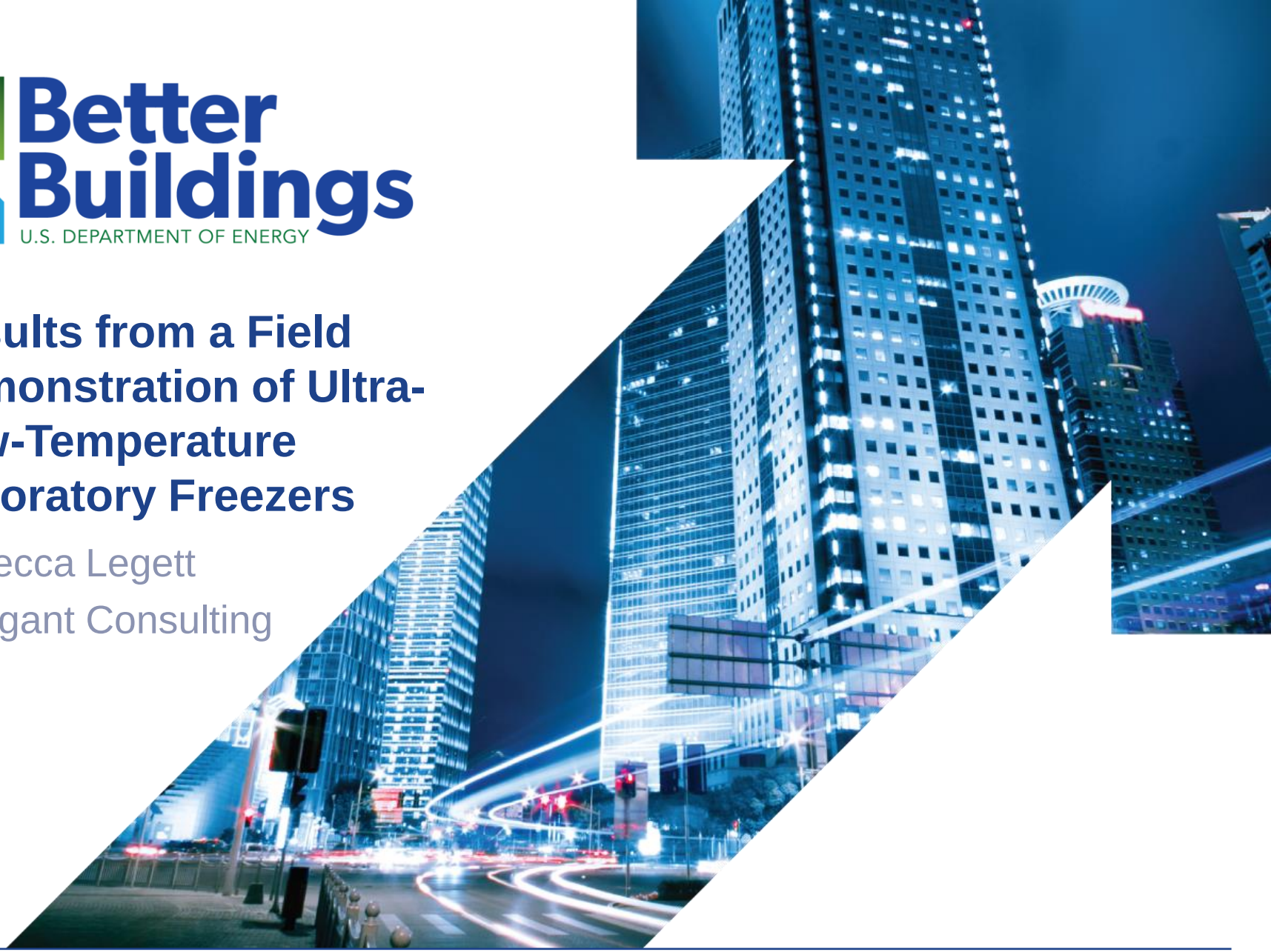

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Introduction: Purpose of the Demonstration

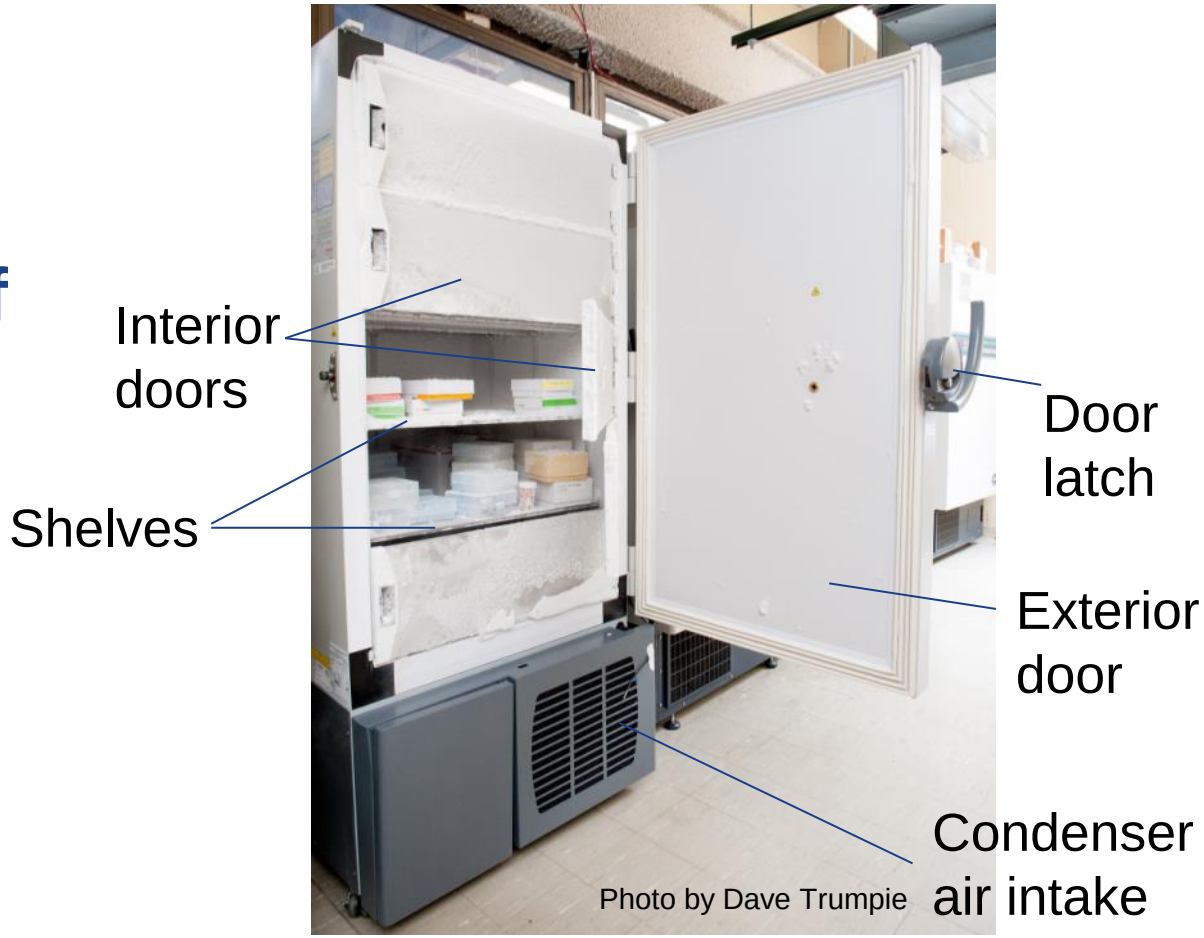
The purpose of the demonstration was to evaluate the energy use of high-efficiency ULTs.

- Goals included:
  - Examine the effect of field conditions on ULT energy use
  - Provide more information to purchasers seeking energy-efficient products
  - Support U.S. Department of Energy (DOE) and Better Buildings Alliance efforts to increase market penetration of high-efficiency ULTs

Introduction: Equipment Description

We examined ULTs with characteristics representative of the market.

- Air-cooled condensing
- Upright configuration
- Cabinet volume of ~20-30 ft^3



Example ULT in the Study

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Methodology: ULTs Included in Demo

We selected three ULTs to evaluate in the demonstration.

- The selected demonstration ULTs:
  - Were within the top 25% of the market in terms of efficiency, based on existing manufacturer and field data*
  - Were manufactured within two years of the demo
  - Incorporated advanced technologies such as vacuum-insulated panels and/or alternative refrigeration system designs

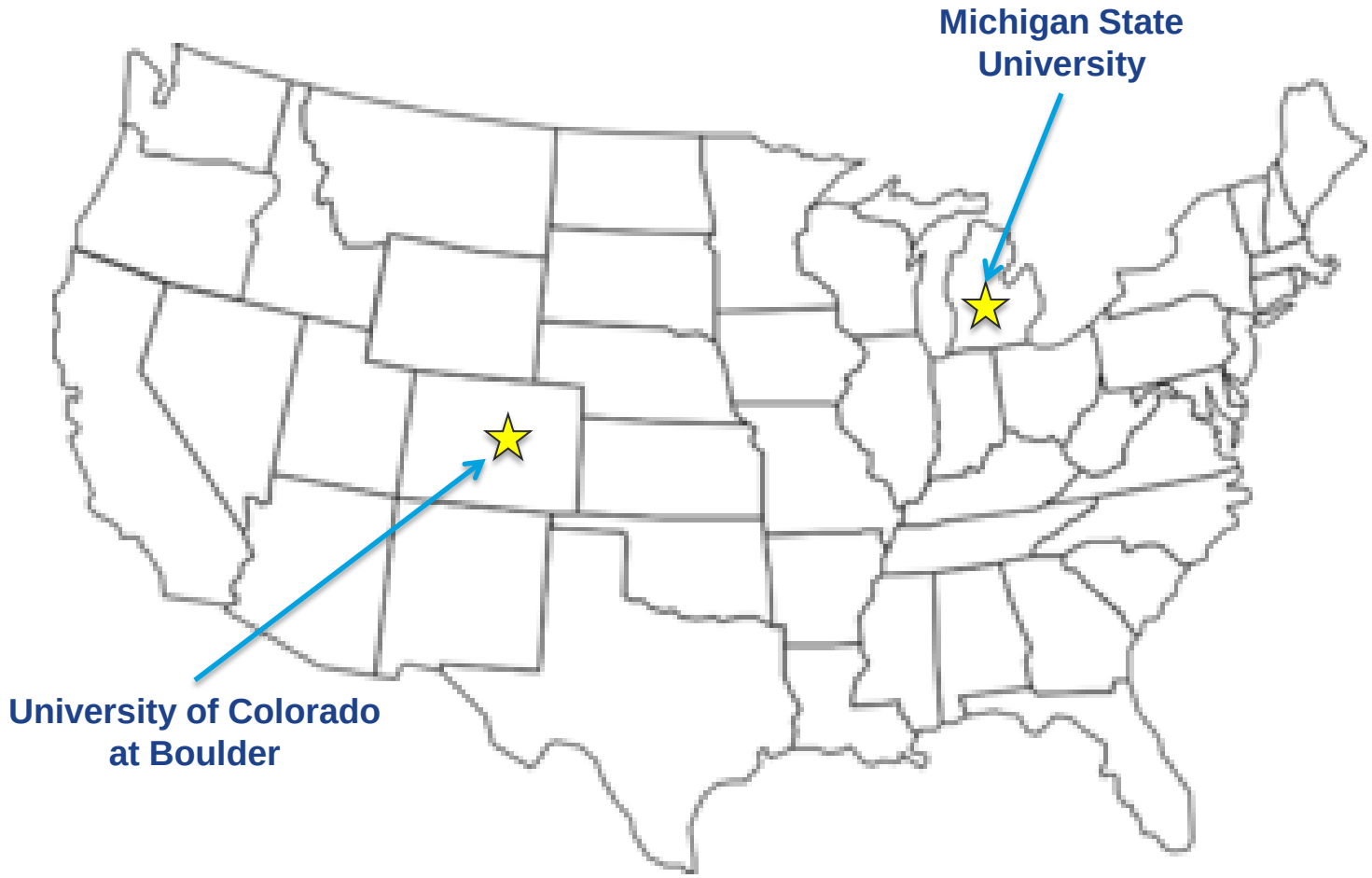
*We were unable to verify the operating conditions and test protocols that the testers or manufacturers used in generating the existing data.

Methodology: ULTs Included in Demo

We monitored each demonstration ULT at one of three sites.

- Molecular, Cellular, and Developmental Biology laboratory at the University of Colorado at Boulder (CU Boulder) in Boulder, CO
- Integrative Physiology laboratory at CU Boulder
- Pharmacology and Toxicology Department at Michigan State University in East Lansing, MI

Methodology: ULTs Included in Demo



Methodology: ULTs Included in Demo

We also evaluated one or more "baseline" ULTs at each site for comparison.

- The baseline ULTs:
  - Were in the same room as the demonstration ULTs at each site and in some cases adjacent to them
  - Were of a similar volume to the demonstration ULTs
  - Were manufactured within the last five years

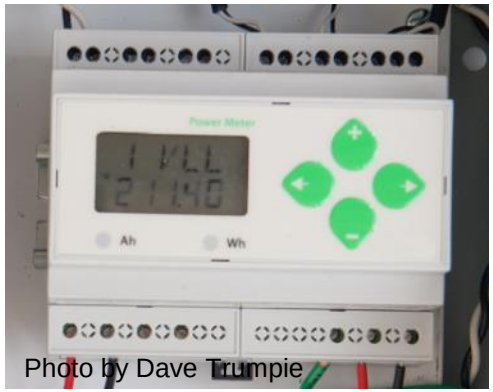
Methodology: ULTs Included in Demo

Details of ULTs Included in the Demonstration

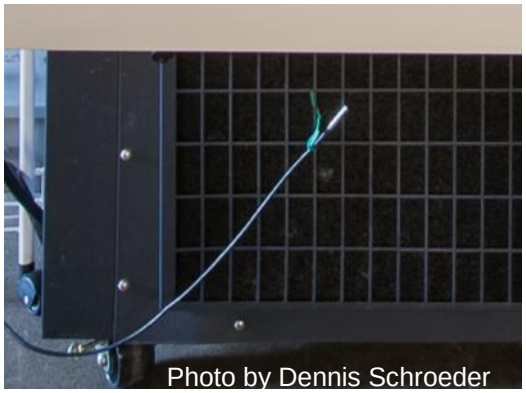
Unit #	Description	Brand/Model Number	Year of Manufacture	Host Site
Demo-1	Demo ULT #1	Stirling Ultracold SU780U	2013	University of Colorado at Boulder - MCDB Lab
Demo-2	Demo ULT #2	New Brunswick HEF U570	2012	University of Colorado at Boulder - iPhy Lab
Demo-3	Demo ULT #3	Panasonic VIP+ MDF-U76VC	2013	Michigan State University
Comp-1	Comparison ULT #1		2010	University of Colorado at Boulder-MCDB Lab
Comp-2	Comparison unit #2		2009	University of Colorado at Boulder - iPhy Lab
Comp-3	Comparison unit #3		2013	Michigan State University
Comp-4	Comparison unit #4		2012	Michigan State University

Methodology: Data Collection

We used instrumentation to collect data for each ULT.



Energy Use: Power Meter



External Temperature: Temp. Sensor

Internal Temperature: Type T Thermocouple

Door Openings: Magnetic State Logger

Methodology: Data Aggregation

We used the collected data to compare energy use of the ULTs.

- Aggregated the data on a daily basis
- Correlated energy use with certain conditions: set-point, external temperature, and door openings
- Compared energy use at a common set of conditions: -80°C setpoint, 22 °C external temperature, and 90 seconds per day of door openings

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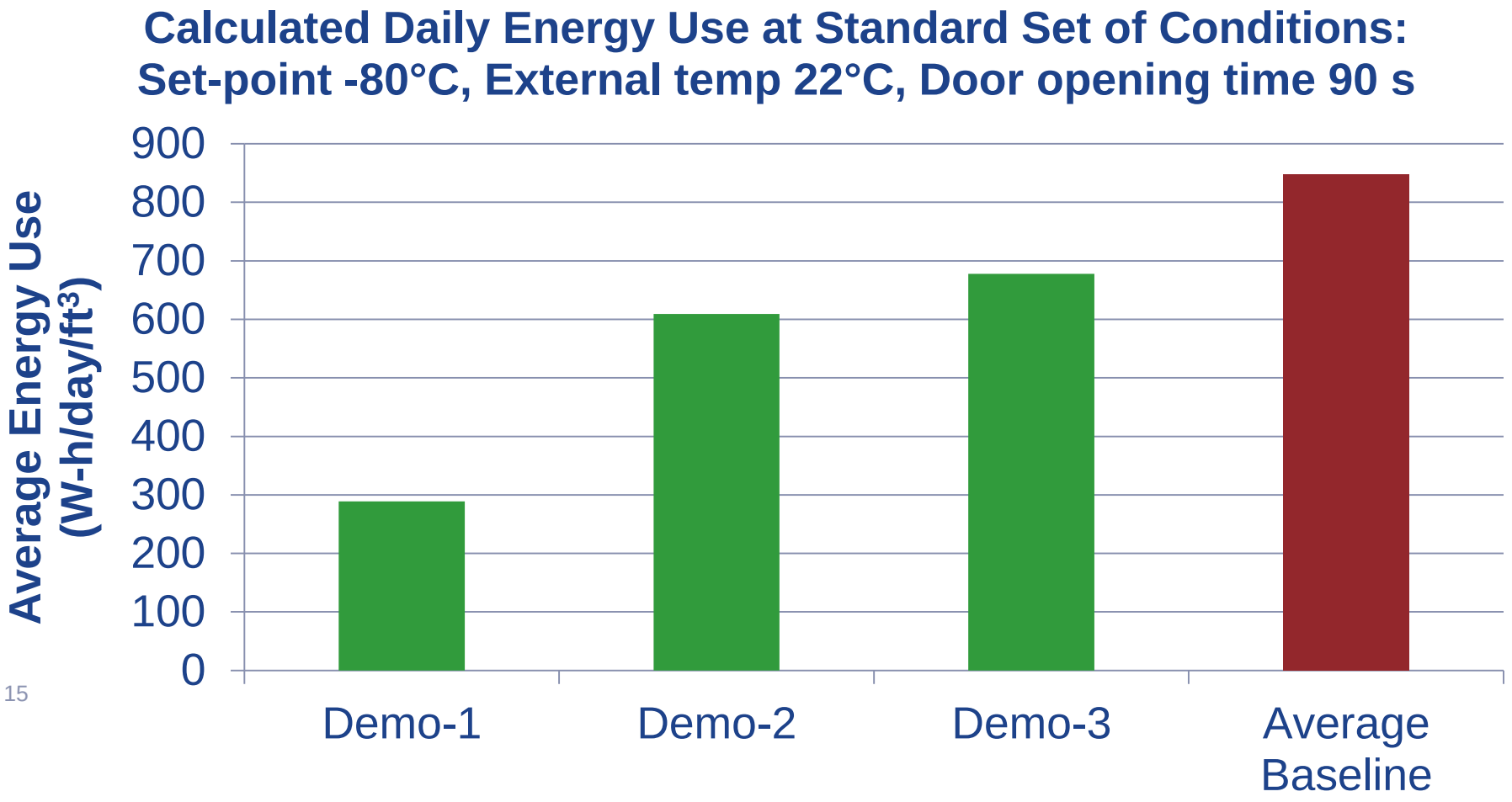
Results: Energy Savings

We observed that the demo ULTs used less energy than the average baseline ULT.



Results: Energy Savings

We conducted a simple payback analysis for each demo ULT vs. the average baseline ULT.

Table 4: Results of Simple Payback Analysis

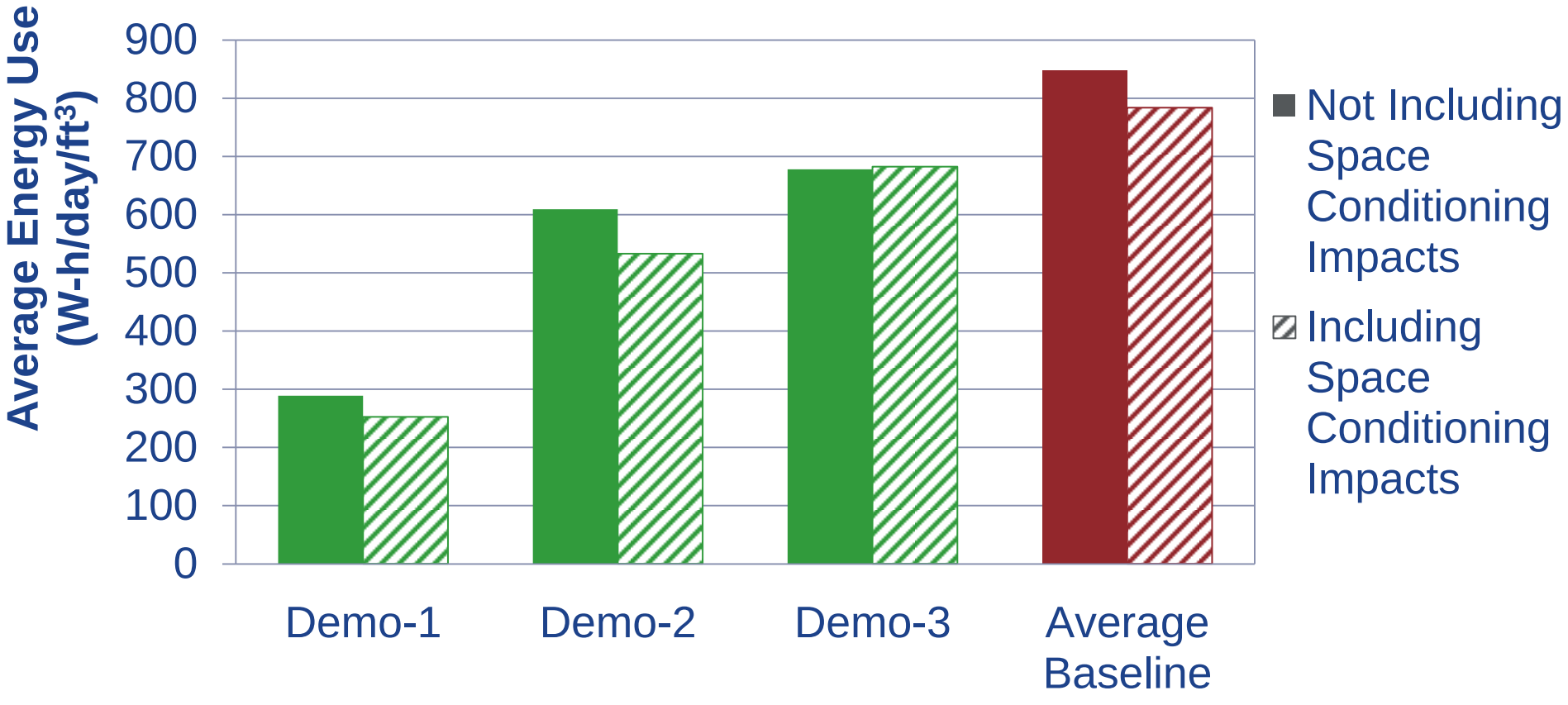
Unit	Percent Energy Savings*	Annualized Energy Savings (MWh)*	Annualized Cost Savings ($)**	Estimated Payback Period (years)†
Demo-1	66%	5.6	$580	3
Demo-2	28%	1.7	$180	9
Demo-3	20%	1.6	$164	15

*Energy savings are normalized to a volume of 25 cubic feet.
**Assuming an average U.S. electricity price of 10.34 cents per kWh (data from Energy Information Administration).
†Calculated against the cost difference between a demo ULT and baseline ULT. Based on 30% discount for both demo and baseline ULTs. Actual prices and payback periods may vary due to distributor discounts.

Results: Energy Savings

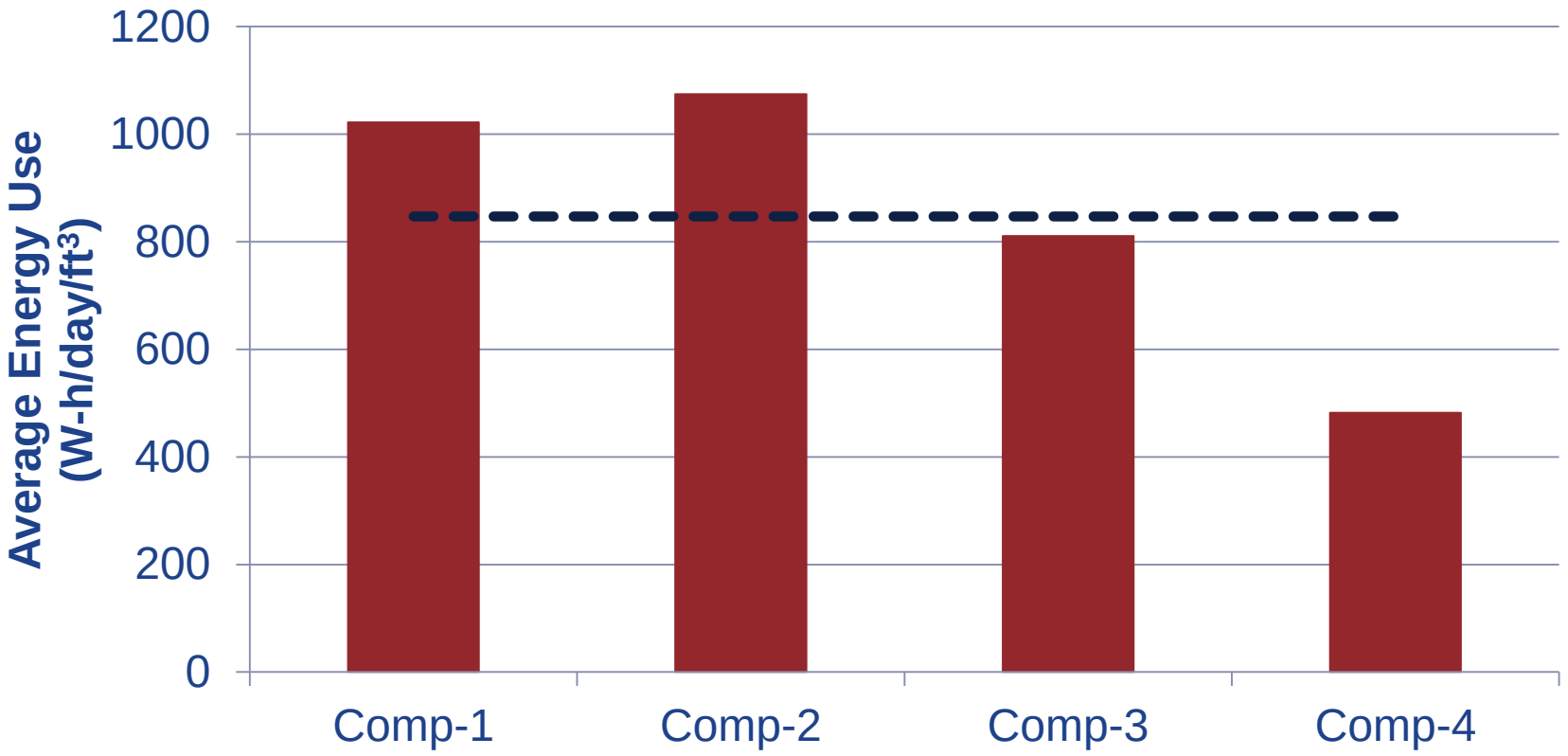
We also calculated energy savings including space conditioning impacts.

Calculated Daily Energy Use at Standard Set of Conditions: Set-point -80°C, External temp 22°C, Door opening time 90 s



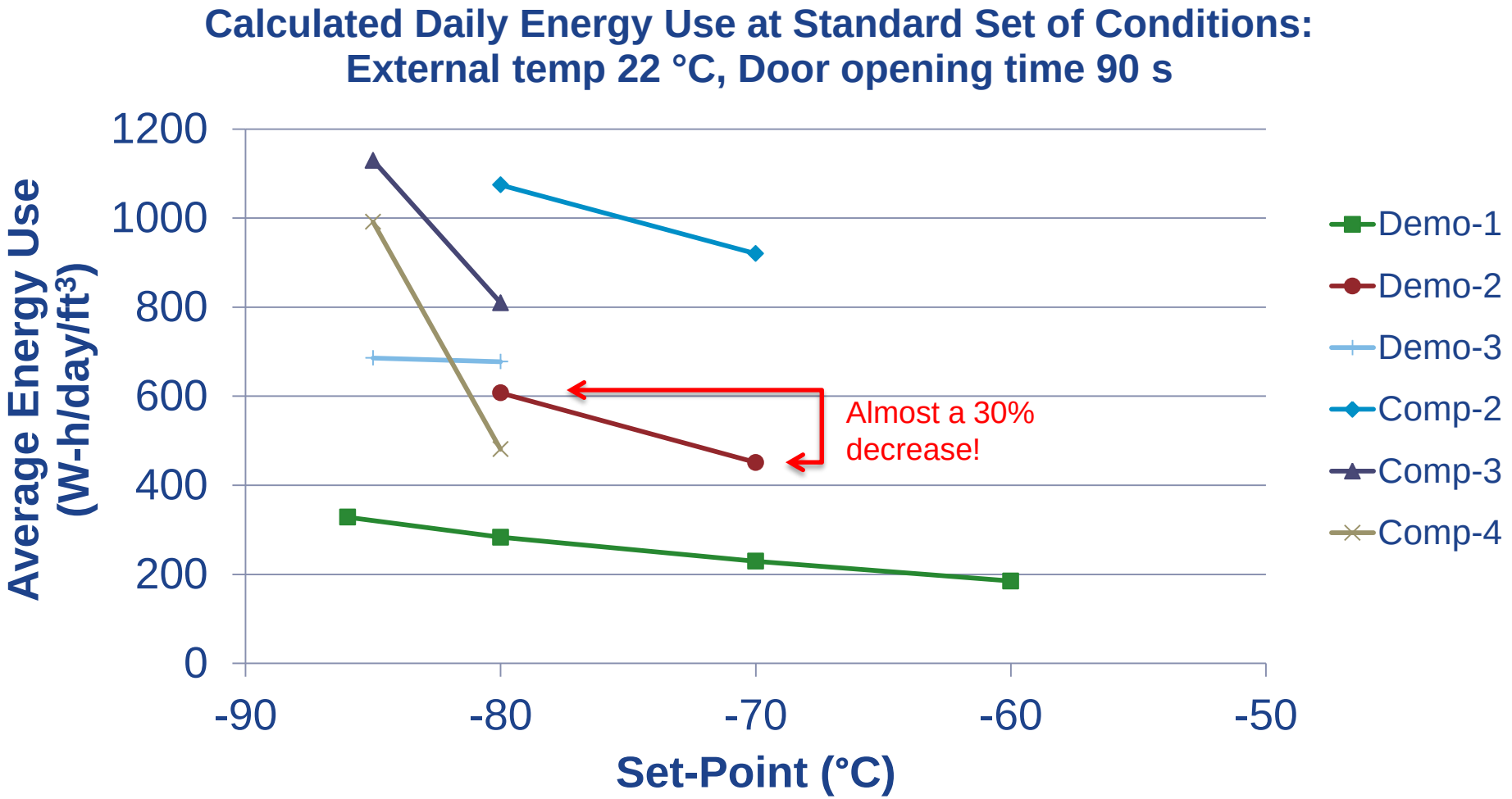
Results: Energy Savings

We observed significant variation in efficiency among the comparison ULTs.



Results: Energy Savings

We observed that operating conditions such as set-point significantly affected energy use.



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Conclusions

The study demonstrated energy savings that were achieved in the field with the demo ULTs.

- Demo ULTs saved between 20% and 66% energy versus the average baseline ULT on a per-cubic-foot basis
- Simple payback analysis estimated payback periods of ~3 to 15 years to recover the cost premium of a demo ULT, depending on the ULT, available discount, and electricity rate.

Next Steps

As an organization that uses ULTs, what can I do to save energy?

- Reduce financial barriers for researchers to purchase efficient ULTs.
- Encourage suppliers to offer high-efficiency products.
- Operate existing ULTs efficiently.

Next Steps

DOE will continue to disseminate the results and support future deployment activities.

- A case study and a detailed report are available on the Better Buildings Alliance website.
- We plan to develop and deploy additional resources to help increase market penetration of high-efficiency ULTs through the HIT (High Impact Technology) Program.

About the Better Buildings Alliance

The Better Buildings Alliance is a DOE effort to promote energy efficiency in U.S. commercial buildings.

- Members commit to addressing energy efficiency needs in their buildings.
- DOE connects members with technical resources and provides platforms for peer exchange.
- Through the HIT program, DOE deploys resources to promote uptake of underutilized but highly efficient building technologies.

Thank you!

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